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(71) Applicant (*for all designated States except US*): MELANESIA INTERNATIONAL TRUST COMPANY LIMITED [VU/VU]; The International Building, Kumil Highway, Port Vila (VU).

(71)(72) Applicant and Inventor: JURISICH, Milne [AU/AU]; Unit 204, 3575 Main Beach Parade, Main Beach, QLD 4217 (AU).

(74) Agent: KELLY, Robin, Thomas; Fisher & Kelly, Level One, 349 Coronation Drive, Milton, QLD 4064 (AU).

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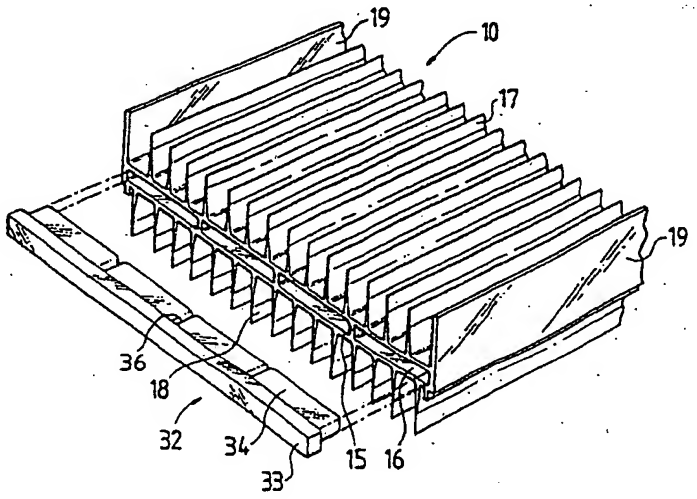

(57) Abstract

Heat exchanger assemblies including one or more suitably a pair of end manifolds (32) and a core (10) comprised of a single heat exchanger element having a hollow body section (16) and a plurality of outwardly extending fins (17, 18) which are open to atmosphere or immersed in solid liquid or other gaseous media whereby a fluid may be passed through the hollow body section (16) for heat exchange purposes. The heat exchanger assembly may be used for diverse applications including subjecting refrigerant to heat exchange when included in a flow circuit for said refrigerant as well as cooling hydraulic fluid associated with hydraulically operated apparatus and also cooling vehicle fuel when included in a fuel line of a vehicle. The heat exchanger assembly may also be used for heating or cooling solid media which should be kept at a constant temperature as well as a room heater or floor heater. The heat exchanger assembly may also be used for cooling insulating oil associated with transformers.

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TITLE

"HEAT EXCHANGER ASSEMBLY"

FIELD OF THE INVENTION

THIS INVENTION relates to heat exchanger assemblies including a core wherein the core has an integral structure and thus may be formed from extrusion or casting. Such assemblies are described as being formed from "primary structure" in contrast to heat exchanger elements being formed from "secondary structure" which may include additional components welded or otherwise attached to the "primary structure".

PRIOR ART

Heat exchange elements or cores formed from primary structure are considered to be more thermally efficient than fabricated heat exchanger elements which constitute "secondary structure" and which may include a number of boundaries constituted by welds or joins. Thus not only is there a possibility of fluid leaks occurring in relation to these boundaries but also such boundaries provide zones of resistance to conduction of heat to heat transmission surfaces of the heat exchanger element.

Heat exchanger elements formed from primary structure are well known and reference may be made for example to US Patents 3,202,212; 4,565,244; 3,743,252; 4,352,008; 3,566,959; 4,567,074; 3,137,785 and 3,467,180 which all show that formation of one piece extrusions as heat exchanger elements are not new.

Reference, however, may be made to GB Patent 2,142,129 which describes a radiator for use in a central heating system having at least one section in the form of a rectangular elongate hollow body which is provided on each of the opposite sides with a plurality of spaced heat radiating fins. However, in this reference the radiator includes a cover plate which extends across the free ends of each set of fins so as to provide a plurality of open ended channels through which can flow air which is heated by a transfer of

heat from a hot fluid flowing through the rectangular hollow body. This reference also describes an embodiment using a multiplicity of rectangular hollow sections. In such embodiment to form the radiator each hollow section must be welded to each other and the terminal hollow sections provided with cover plates.

A heat exchanger comprising a plurality of modules each having a plurality of channels spaced from each other and located in a central body part and also a plurality of fins extending outwardly on each side of the central body part is also described in US Patent 4,401,155. However the total heat exchanger assembly formed by a plurality of such modules is described as being particularly suited for high pressure applications such as cryogenic processes for example fluid liquefier processes and liquid pumping oxygen processes.

A particular deficiency of the abovementioned prior art is that they all describe heat exchanger elements or heat exchanger assemblies of such elements which are restricted to a particular application as in the case of GB Patent 2,142,129 or US Patent 4,401,155.

OBJECTS OF THE INVENTION

It therefore is an object of the invention to provide a heat exchanger assembly having a core formed of primary structure which may be used in a variety of different applications and is thus versatile in nature.

SUMMARY OF THE INVENTION

The heat exchanger assembly of the invention includes one or more suitably a pair of end manifolds and a core comprised of one or more heat exchanger elements wherein the or each heat exchanger element has a hollow body section and a plurality of outwardly extending fins which are open to atmosphere or immersed in solid, liquid or other gaseous media. A fluid may be passed through the core from one end manifold to the other.

In an alternative arrangement fluid may be forced through

the core by a pump or other suitable means when only an inlet manifold is used or alternatively may be exhausted through the core by appropriate means such as an exhaust pump when only an outlet manifold is used.

In this aspect of the invention the angle of entry or exit from the core of fluid passing through the or each hollow body section is not important and thus the end manifolds may enable the fluid to pass through each manifold and the core in a straight line or the angle of entry or exit may be at an angle to the longitudinal axis of the core.

Alternatively the fluid may pass through the or each hollow body section in serpentine fashion. In this regard the or each hollow body section may be provided with one or more webs so that parallel flow passages are formed wherein the fluid may make a number of passes through different flow passages as may be required. In this regard each end manifold may also be provided with diversion recesses to achieve a serpentine flow as well as access slots.

Preferably each end manifold is in the shape of a tube of similar internal dimensions to the hollow body section although this is not essential.

It is a feature of the invention that the heat exchanger element may be used in the form of heat exchanger strips and the length of each strip may be dictated by the requirements of a particular application. The fins of each element in accordance with one embodiment of the invention are open to atmosphere in use so that heat may be radiated to atmosphere by convection.

The heat exchanger assembly of the invention therefore may have a variety of different applications. Examples of such applications may be discussed below.

In relation to refrigerators, the conventional heat exchanger assembly for a refrigerator may be replaced by one or more heat exchanger elements of the invention.

Thus, for example, a plurality of heat exchanger elements

in accordance with the invention may be mounted to the rear of the refrigerator in substantially parallel relationship interconnected by connection manifolds. A feed line and return line for refrigerant may be connected to appropriate end manifolds of suitable heat exchanger elements. The heat exchanger assembly may be arranged so that the refrigerant (e.g. FREON gas) passes through the hollow body section with the external fins radiating heat from the refrigerant to atmosphere by convection.

In another application the heat exchanger assembly of the invention may be used to cool the hydraulic fluid associated with hydraulic assemblies (e.g. hydraulic ram assemblies) of trucks. For example, such hydraulic ran assemblies may be used to tilt trays for unloading purposes or for actuation of compactor mechanisms. The heat exchanger elements or cores may be attached to the chassis of the truck in any suitable manner and connected by appropriate manifolding to a hydraulic fluid circuit which may include a source of hydraulic fluid, a pump, a feed line to the hydraulic ram assembly or assemblies and a return line to the hydraulic fluid source. The heat exchanger assembly is suitably included in the return line and again the spent hot fluid may be passed through the hollow body of the core and the heat discharged to atmosphere from the outwardly extending fins by convection.

In similar fashion the heat exchanger assembly of the invention may be utilised for hydraulic ram assemblies associated with agricultural machinery, earthmoving equipment or mobile cranes.

In relation to hydraulic presses the heat exchanger assembly of the invention may be mounted to a base surface of a hydraulic press.

In all of the abovementioned applications in relation to cooling of hydraulic fluid, the heat exchanger assembly of the invention will cool the hydraulic fluid as described above, i.e. by the outwardly extending fins radiating heat to atmosphere.

The heat exchanger assembly of the invention may also be used in relation to apparatus actuated by pneumatically controlled control apparatus e.g. by pneumatically operated ram assemblies in a similar manner as described above in relation to hydraulically operated apparatus, i.e. by the inclusion of the heat exchanger assembly in a return line of the pneumatic fluid circuit. This will apply to pneumatically operated machinery as well as pneumatically operated tools and the like.

From the foregoing it will also be appreciated that the heat exchanger assembly of the invention may be used in a variety of different applications inclusive of marine applications, industrial applications and waste treatment applications.

The heat exchanger assembly of the invention may also be used for heating purposes, e.g. in relation for use as a floor heater or room heater as described hereinafter. In this situation the outwardly extending fins are not open to atmosphere but may be immersed in solid media such as concrete.

However, it will also be appreciated that the heat exchanger assembly of the invention may be immersed in any other suitable solid media such as rubber or aluminium for heating or cooling purposes when it is desired that the solid media be maintained at constant temperature. This may be important, for example, in food processing or manufacture of silicon clips.

In relation to the heat exchanger element of the invention, preferably the hollow body section is bounded by an endless peripheral wall and the plurality of fins extend outwardly from the peripheral wall. The hollow body sections may therefore comprise a flow channel for any one of the fluids described previously which may include liquids such as hydraulic fluid or gases such as air. Preferably the hollow body section is provided with one or more webs wherein the or each web extends from opposed surfaces fo the peripheral wall to define one or more fluid flow passages. The webs

are useful for straightening and reinforcement purposes to maintain the structural integrity of the core.

It is an important feature of the present invention that the peripheral wall and the elongate fins of each module are each formed simultaneously in formation of the one piece extrusion or casting so that the heat exchanger module is formed from primary structure. In other words no secondary structure is present which can lead to disadvantages as discussed above. Also the internal fluid passages in the core and external flow passages created by spaces between adjacent fins are substantially parallel to each other to form a parallel flow heat exchanger core which has advantages over conventional cross flow heat exchangers. These advantages include the following:

(i) a parallel flow arrangement facilitates ducting of air both to and from the heat exchanger core. A fan may then be used to draw the air through and the hot air away from the heat exchanger core. This means that the heat exchange core used in the heat exchanger assembly of the invention does not have to rely upon ambient air passing through when used, for example, as a radiator in a motor vehicle. Therefore the heat exchanger core of the invention need not be located in front of the vehicle.

(ii) when used as a radiator, the heat exchanger core used in the heat exchanger assembly of the invention need not have a large flat surface as is the case with a conventional radiator. Therefore it can be designed in a far more compact configuration. This means that the shape of the vehicle may be changed to permit reduced wind resistance in the case of a truck or increased usage of the interior in the case of a coach or bus.

(iii) the ducting of the hot air away from the heat exchanger core also facilitates the use of the hot air for other purposes such as for the supply of heat or as a power source.

(iv) because the fluid passages are parallel this means

that the heat exchanger element of the invention may be manufactured as a one piece extrusion. An extrusion could not be satisfactorily produced in the case of a crossflow arrangement. This also means that the fins form an integral part of the heat exchanger core of the invention rather than being crimped, welded or soldered to the part. This avoidance of secondary structure maximises conductivity of the heat from the fluid to be cooled to the other fluid.

(v) as a consequence of (iv) above the one piece extrusion may be cut to any desired length and may be designed to be releasably attached to other heat exchanger components such as end manifolds. Not only length but height and width are all flexible and may be varied to suit the particular application desired.

(vi) the heat exchanger core of the invention when compared to the prior art is far more efficient and also lighter. It also requires less power from the main power sources (e.g. and engine or motor) for operational purposes.

The core used in the heat exchanger assembly of the invention may have any suitable configuration. For example, the core may comprise a continuous cross section of indefinite length with the flow passages being disposed in the direction of the indefinite length. Such a configuration has proved to be particularly amenable to continuous casting or extrusion.

Preferably the peripheral wall of each module is substantially rectangular having a pair of opposed substantially horizontal parts in use which are joined by a pair of opposed vertical parts. The abovementioned webs of the primary fluid section formed by the peripheral wall are preferably substantially parallel to the vertical parts.

However it will also be appreciated that the peripheral wall may have any other suitable shape such as being circular in cross section or triangular in cross section or polygonal in cross section.

The flow passages of the hollow section may have any

suitable shape or configuration and thus may be round, rectangular or polygonal in cross section.

It will be appreciated that the configuration of the flow passage or passages will depend upon the application of the heat exchanger and will also significantly depend upon the material of manufacture of the heat exchanger core.

It will also be appreciated that the elongate fins may have any suitable shape. Preferably however each fin is of constant height and width although this is not absolutely essential. Thus for example each elongate fin is of constant height and width although this is not absolutely essential. Thus for example each elongate fin may taper in width from one end to the other if required if the heat exchange element of the invention is produced as a casting. The elongate fins may also have projections or ribs on an outer surface to increase their surface area if required.

It is also within the scope of the invention to have internal fins located in the flow passages of the body part if such is considered appropriate.

Heat exchanger cores in accordance with the present invention may be used to process any suitable fluid such as gas or liquid which may be passed through the hollow body section. This may be air but may also include other heat transfer fluids such as water, ethylene glycol, ammonia, fluorocarbon compounds, silicone compounds, mineral oils and the like.

The heat exchanger cores of the present invention may be of any suitable material, the suitability of a material being generally determined with reference to the application to which it is to be put. For example, use in extreme high temperature applications may dictate that a ceramic material be used for its high temperature properties, whereas for lower temperature applications it has been found that aluminium or its alloys or other metals are suitable for their relatively high thermal conductivities, permitting thicker wall sections

per unit efficiency and thus increasing mechanical strength.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference may now be made to a preferred embodiment of the invention as shown in the attached drawings wherein:

FIG. 1 is a perspective view of in a heat exchanger core utilised in the heat exchanger assembly of the invention;

FIG. 2 is a cross sectional view of the heat exchanger core shown in FIG. 1;

FIG. 3 is a cross sectional view of a heat exchanger core which may be utilised in the heat exchanger assembly of the invention wherein the fins have a different configuration to that shown in FIG. 1;

FIG. 4 is a cross sectional view of a heat exchanger core different to that shown in FIGS 1-3;

FIG. 5 is a perspective view of a heat exchanger assembly of the invention including a plurality of heat exchanger cores joined end-to-end;

FIG. 6 is a side view of a heat exchanger assembly of the invention showing heat exchanger cores in stacked relationship;

FIG. 7 is a perspective view of a heat exchanger assembly of the invention comprising heat exchanger cores arranged in a side-by-side arrangement;

FIG. 8 is a perspective view of a heat exchanger assembly of the invention including a core and associated end manifold;

FIG. 9 is a perspective view similar to FIG. 8 but illustrating a different type of manifold;

FIG. 10 is a perspective view similar to FIG. 9 but illustrating an end manifold different to that shown in FIGS 8-9;

FIG. 11 is a schematic view of a heat exchanger assembly of the invention showing one type of serpentine flow through the core;

FIG. 12 is a similar view to FIG. 11 showing a different type of serpentine flow to that shown in FIG. 11;

FIG. 13 is a perspective view of a heat exchanger assembly of the invention showing heat exchanger elements in a side-by-side arrangement with associated end manifolds;

FIG. 14 is a similar view to FIG. 11 showing a different flow arrangement;

FIG. 15 is a similar view to FIG. 12 showing the use of different end manifolds;

FIG. 16 is a similar view to FIG. 13 showing the use of different end manifolds;

FIG. 17 is a perspective view of a refrigerator having a heat exchanger assembly of the invention associated therewith;

FIG. 18 is a flow circuit of refrigerant in the heat exchanger assembly of FIG. 17;

FIG. 19 is a perspective view of a wall heater utilising a heat exchanger assembly of the invention;

FIG. 20 is a perspective view of a skirting board assembly of a room utilising a heat exchanger assembly of the invention;

FIG. 21 is a view of a room heater using a heat exchanger assembly of the invention;

FIG. 22 is a flow circuit applicable to FIGS 19, 20 or 21;

FIG. 23 is a view of a fuel cooling system for a vehicle utilising a heat exchanger assembly of the invention;

FIG. 24 is a view of a flow circuit applicable to the fuel cooling system of FIG. 23;

FIG. 25 is a view of a flow circuit applicable to any form of hydraulically operated apparatus;

FIG. 26 is a perspective view of a heat exchanger assembly of the invention utilised with an oven or stove for the purpose of generating heat; and

FIG. 27 is a view of a flow diagram utilising a heat exchanger assembly of the invention for the purpose of cooling a transformer.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1 there is shown heat exchanger element or core 10 in accordance with the invention having a peripheral wall 11 of shallow rectangular configuration which has opposed horizontal parts 12 and opposed vertical parts 13. The peripheral wall 11, which is of a continuous nature, defines a closed fluid section 14. Webs 15 are included to define separate flow passages 16.

There are also included a first array of fins 17 extending away from one horizontal part 12 and a second array of fins 18 extending away from the opposed horizontal part 13 of peripheral wall 11. End walls 19 may also be included although these walls could be the same height as fins 17 if desired. The fins 17 and 18 may extend into atmosphere or be embedded in a solid medium as described hereinafter.

In relation to FIG. 2 there is shown a heat exchanger core 10 having fins 17 and 18 in staggered relationship with each other as shown in FIG. 1. Ribs 16A may also be utilised for releasably interconnecting adjacent cores 10 to each other if desired in either stacked or side-by-side arrangement.

In FIG. 3 there is shown core 10A wherein fins 17A and 18A may be in opposed relationship.

In FIG. 4 there is shown core 10B having outwardly projecting fins 20, peripheral wall 21 having a circular shape as shown and separate flow passages 22 constituted by reinforcing webs 23 joined to an axial longitudinal rib 24.

In FIG. 5 there is shown adjacent heat exchanger assemblies comprising cores 10, end manifolds 25, and corner manifolds 26 for facilitating flow of fluid between adjacent cores 10.

In FIG. 6 there is shown manifolds 10 in a stacked

relationship or parallel arrangement wherein fluid flow may be facilitated by interconnecting manifolds 26.

In FIG. 7 there is an arrangement whereby adjacent cores 10 are aligned vertically and side-by-side to be interconnected by end manifolds 27 facilitating flow of fluid between adjacent manifolds 10.

FIG. 8 illustrates one form of attachment of an end manifold to an adjacent core or element 10 wherein fins 17 and 18 are spaced from the respective ends of peripheral wall 11 to define a retaining ledge 28 for engagement of end manifold 30. Any form of releasable attachment means (not shown) may be utilised to attach manifold 30 to core 10.

FIG. 9 illustrates another form of attachment of manifold 32 to core 10 where manifold 32 includes a longitudinal support 33 having a plurality of separate components 34 each of which may be accommodated within a respective flow passage 16. As in the case of FIG. 8, any form of releasable attachment means (not shown) may be utilised to attach manifold 32 to core 10. Partitions 15 may engage with a respective slot 36 as shown.

FIG. 10 shows a similar view to FIG. 9 but illustrating the feature of the partitions 15 being cut away at 35 from the ends of flow sections 14 to accommodate components 34 of manifolds 32A.

FIG. 11 shows a heat exchanger assembly 37 in accordance with the invention wherein one or more cores 10 having flow passages 16 co-operates with end manifolds 38 and 39 so as to produce a serpentine flow path of fluid in flow passages 16 as shown.

FIG. 12 shows a heat exchanger assembly 40 in accordance with the invention wherein one or more cores 10 having flow passages 16 co-operates with end manifolds 41 and 42 to produce a serpentine flow different to that shown in FIG. 11.

FIG. 13 shows a heat exchanger assembly 43 of the invention wherein core 44 comprising a plurality of elements 10 is associated with end manifolds 44A and 45 whereby end manifold 44

functions as an inlet manifold while manifold 45 functions as an outlet manifold. The inlet 45A and outlet 45B are indicated by the arrows.

FIG. 14 shows a heat exchanger assembly 46 wherein one or more cores 10 having flow passages 16 co-operate with end manifolds 47 and 48 to achieve the flow path shown whereby fluid may pass from one fluid channel 16 into an adjacent fluid channel 16 by the provision of slots 49A.

FIG. 15 shows a heat exchanger assembly 49 having a similar flow path to that shown in FIG. 14.

FIG. 16 shows a heat exchanger assembly 50 similar to that shown in FIG. 13 wherein one end manifold 51 functions as an inlet-outlet manifold and another end manifold 52 functions purely for diverting fluid flow from one fluid passage 16 into an adjacent fluid passage 16. The inlet 44A and outlet 44B are shown by the arrows. The heat exchanger 50 may be used to obtain the flow paths shown in FIGS. 14-15.

FIG. 17 shows a refrigerator 52 having a heat exchanger assembly 53 in accordance with the invention attached to a rear wall 54 thereof. Such heat exchanger may utilise a serpentine flow path of refrigerant as described above.

In the flow circuit of FIG. 18 heat exchanger 53 may comprise the evaporator shown in the flow circuit which relates to the passage of refrigerant from a refrigerant reservoir, and subsequently through a compressor or pump to the condenser before passage to the evaporator.

FIG. 19 shows a heat exchanger assembly 54 being utilised as a room heater 55 wherein heat may be radiated from the fins to warm the room as shown by the arrows in full outline by passage of a heated liquid (e.g. heated water or oil) passing through the assembly 54 from inlet 56 to outlet 57 which is also facilitated by end modules 58 and 59.

FIG. 20 shows the provision of a skirting board 60

functioning as a room heater of a room comprising individual cores 10 interconnected by manifolds 25 and 26 as shown in FIG. 5 wherein the arrows indicate the heat energy being radiated outwardly from skirting board 60.

FIG. 21 shows the immersion of a heat exchanger assembly 61 of the invention in solid media such as concrete as described previously which may also function as a room heater as shown by the arrows in full outline.

FIG. 22 shows a flow circuit suitable for any one of FIGS. 19, 20 or 21 wherein a furnace or boiler may provide heated air or water for provision of heat which may be pumped through the circuit as shown.

FIG. 23 shows a heat exchanger assembly 62 of the invention being utilised as cooling medium for fuel in a vehicle 63. In this situation fuel from engine 64 is passed through conduit 65 to heat exchanger assembly 62 which may comprise a single element 10 or a plurality of elements 10 connected in series. There is also shown fuel tank 66 which passes fuel to the engine through conduit 65.

FIG. 24 shows a flow circuit suitable for the FIG. 23 arrangement. The fuel pump associated with engine 64 passes the fuel through the fuel injectors before the hot fuel is passed to heat exchanger assembly 62 for cooling purposes.

As described above, a heat exchanger assembly of the invention may also be utilised for the purposes of cooling hydraulic fluid associated with any form of hydraulically operated apparatus as shown in the flow circuit of FIG. 25.

In the arrangement shown in FIG. 26 a "pot bellied" stove 67 may have a heat exchanger assembly 68 functioning as a flue for gases emanating from stove 67 which may provide a source of heat energy as shown by the arrows in full outline. There also may be provided a water jacket 69 whereby the gases may be utilised for heating water passed into jacket 69 via inlet conduit 70 and outlet

conduit 71. A further heat exchanger assembly 68 may also be connected to water jacket 69 for heating purposes.

Finally, in FIG. 27 there is shown how the heat exchanger assembly of the invention may be utilised for cooling insulating oil associated with transformers wherein a cooler bank of cores 10 as shown in FIG. 7 may be used to cool the insulating oil which is passed back to the transformer through the agency of the pump as shown. In some cases the pump may be omitted and fluid flow may occur through natural convection.

CLAIMS

1. A heat exchanger assembly including one or more suitably a pair of end manifolds and a core comprised of one or more heat exchanger elements wherein the or each heat exchanger element has a hollow body section and a plurality of outwardly extending fins which are open to atmosphere or immersed in solid liquid or other gaseous media whereby a fluid may be passed through the or each hollow body section for heat exchange purposes.

2. A heat exchanger assembly as claimed in Claim 1 wherein there is provided a pair of manifolds located at each end of the or each hollow body section.

3. A heat exchanger assembly as claimed in Claim 2 wherein one end manifold is an inlet manifold and the other end manifold is an outlet manifold.

4. A heat exchanger assembly as claimed in Claim 2 wherein one end manifold functions as an inlet as well as an outlet for said fluid.

5. A heat exchanger assembly as claimed in Claim 2 wherein the fluid passes through the or each hollow body section in a serpentine flow path.

6. A heat exchanger assembly as claimed in Claim 2 wherein the fluid makes a single pass through the or each hollow body section.

7. A heat exchanger assembly as claimed in Claim 2 wherein the or each hollow body section is provided with one or more partitions or webs so as to provide a plurality of separate flow passages.

8. A heat exchanger assembly as claimed in Claim 1 comprising a plurality of said heat exchanger elements whereby each element is connected to each other in end-to-end arrangement so as to provide an elongate strip.

9. A heat exchanger assembly as claimed in Claim 1

comprising a plurality of said heat exchanger elements whereby each element is connected to each other in a side-by-side arrangement.

10. A heat exchanger assembly as claimed in Claim 5 for use in refrigerators whereby refrigerant from the refrigerator may be passed through said heat exchanger assembly.

11. A heat exchanger assembly as claimed in Claim 1 for use in cooling hydraulic fluid associated with hydraulically operated apparatus whereby said heat exchanger assembly is connected in a return line of a hydraulic fluid circuit including said hydraulically operated apparatus as well as a reservoir for said hydraulic fluid and pump means.

12. A heat exchanger assembly as claimed in Claim 1 for use as a room heater or floor heater wherein said heat exchanger assembly is included in a flow circuit comprising a source of heated fluid and a pump whereby said heated fluid may be passed through said heat exchanger assembly for the purpose of providing heat energy.

13. A heat exchanger assembly as claimed in Claim 12 wherein said heat exchanger assembly comprises a plurality of heat exchanger elements connected in end-to-end relationship by manifolds located between adjacent heat exchanger elements so as to provide an elongate heating strip which may be utilised as a skirting board for a room of a building.

14. A heat exchanger assembly as claimed in Claim 1 for use in heating or cooling solid media wherein said heat exchanger assembly is embedded in said solid media and said fluid may be utilised to heat or cool said solid media.

15. A heat exchanger assembly as claimed in Claim 1 for use in cooling fuel of vehicles whereby vehicle fuel is passed through said heat exchanger assembly prior to being transferred to a vehicle engine.

16. A heat exchanger assembly as claimed in Claim 1 for use

in cooling insulating oil associated with transformers wherein a cooler bank comprising a plurality of said heat exchanger assemblies is used to cool insulating oil associated with said transformers.

17. A method of heat exchanging refrigerant associated with refrigerators including the step of including in a flow line for said refrigerant a heat exchanger assembly as claimed in Claim 1 in association with a condenser and a reservoir for said refrigerant as well as a compressor.

18. A method of cooling hydraulic fluid associated with hydraulically operated apparatus including the step of including a heat exchanger assembly as claimed in Claim 1 in a return line of a hydraulic fluid circuit for said hydraulic fluid which also includes a reservoir for said hydraulic fluid, said hydraulically operated apparatus and a pump means for pumping said hydraulic fluid.

19. A room heater including a heat exchanger assembly as claimed in Claim 1 wherein said one or more end manifolds are connectable to a source of heated fluid.

20. A room heater as claimed in Claim 19 wherein said heat exchanger assembly comprises a plurality of said heat exchanger elements connected in end-to-end arrangement by said end manifolds whereby said end manifolds interconnects adjacent heat exchanger elements.

21. A method of cooling vehicle fuel which includes the step of including a heat exchanger assembly as claimed in Claim 1 in a flow line for said vehicle fuel in a vehicle whereby vehicle fuel is cooled by said heat exchanger assembly prior to being transferred to a vehicle engine included in said flow line.

22. A method of heating or cooling solid media including the step of embedding a heat exchanger assembly as claimed in Claim 1 in said solid media and allowing said fluid to be passed through said heat exchanger assembly for heating or cooling purposes.

23. A method of cooling insulating oil associated with

transformers including the step of including a heat exchanger assembly in a flow line for said insulating oil whereby said insulating oil is cooled prior to being passed to a transformer which is immersed in said insulating oil.

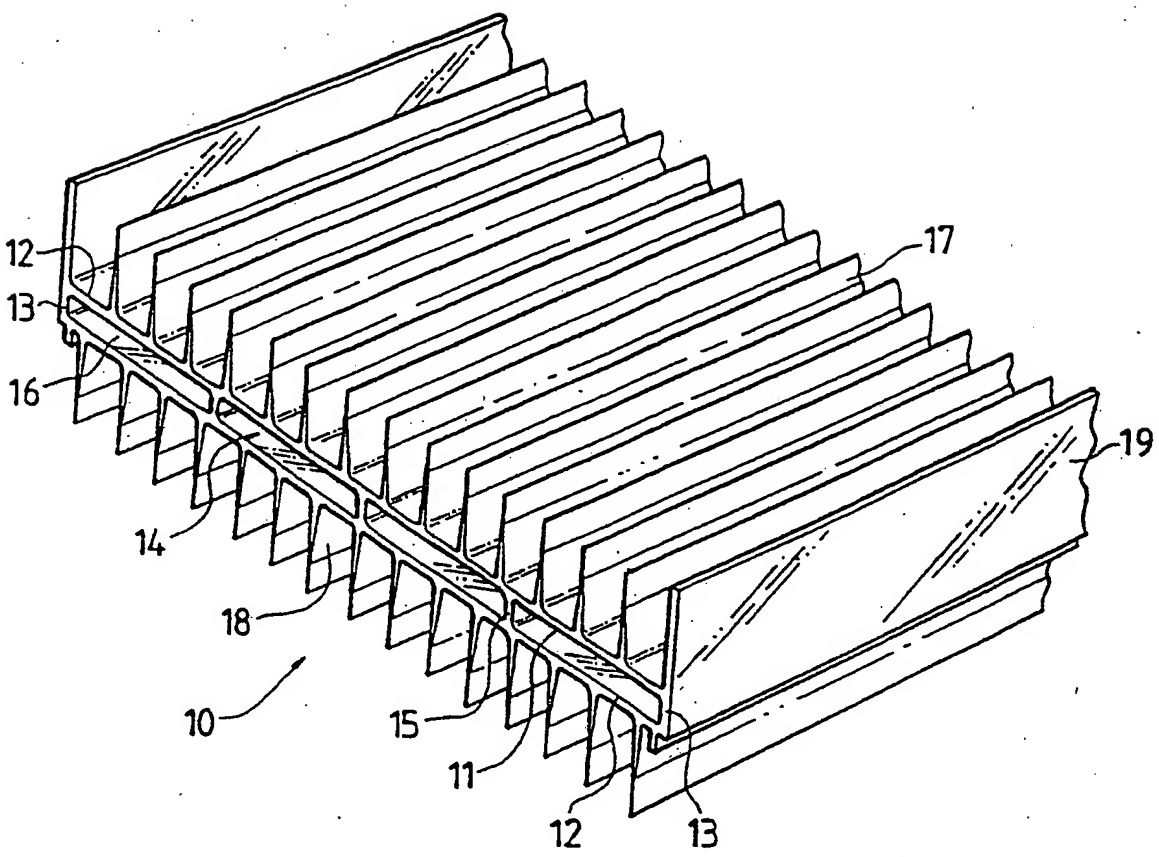

FIG. 1

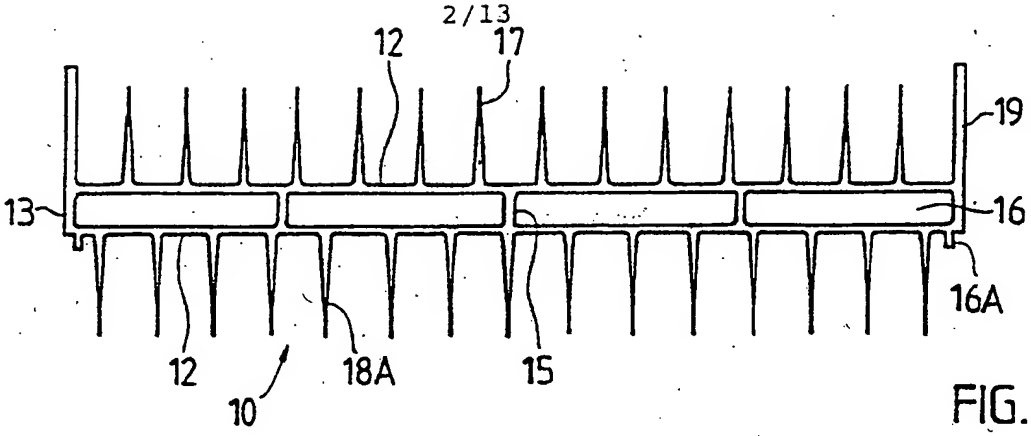

FIG. 2

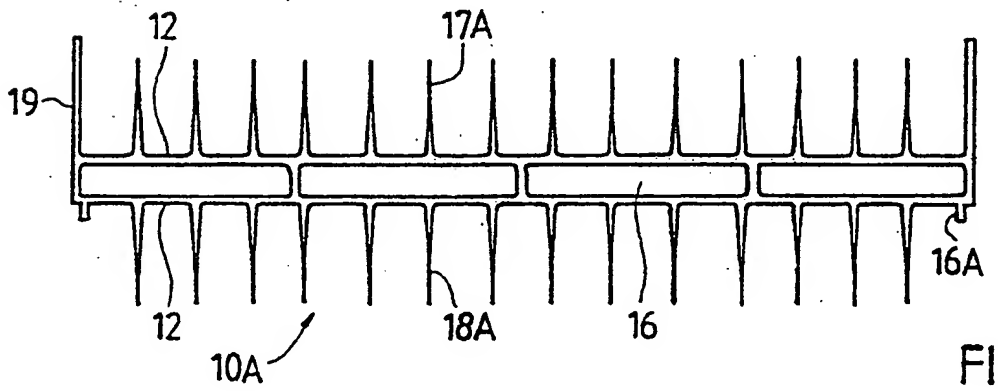

FIG. 3

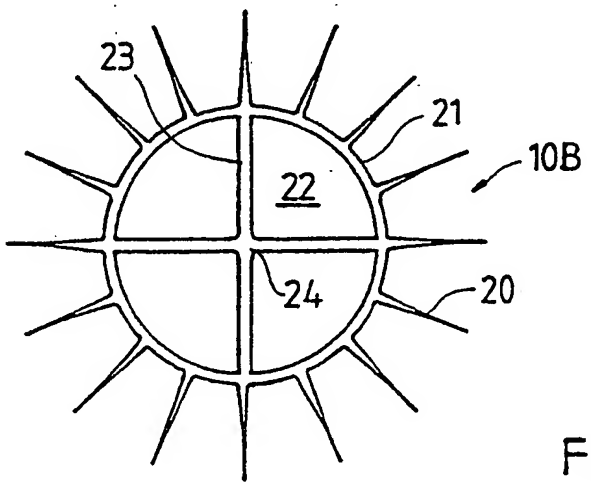

FIG. 4

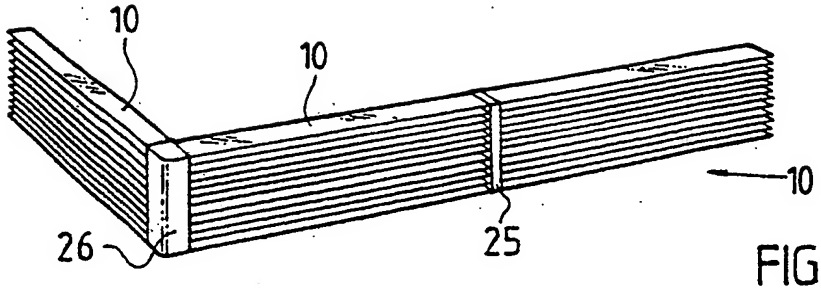

FIG. 5

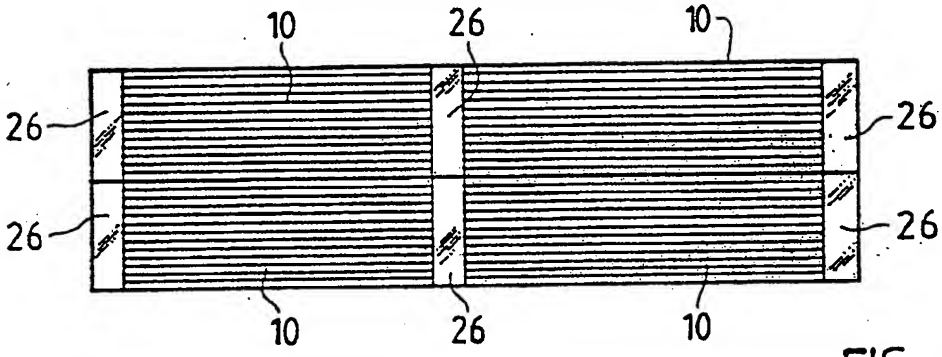

FIG. 6

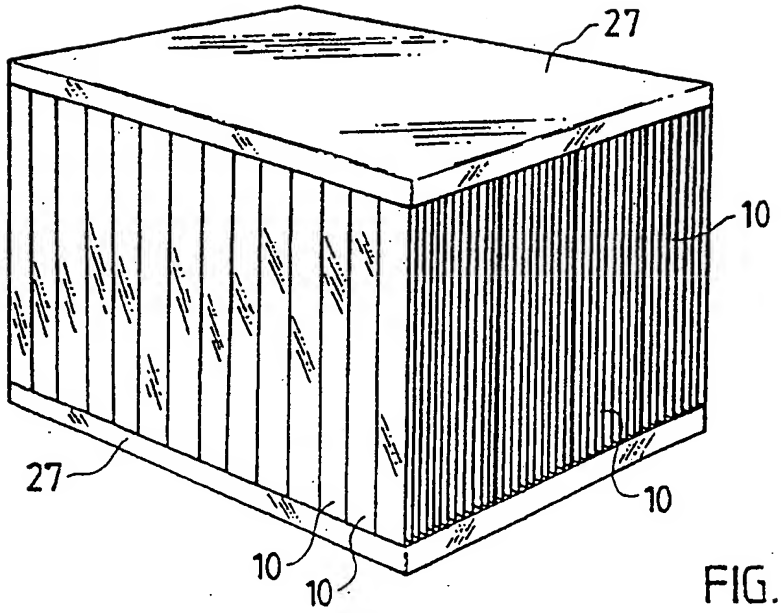

FIG. 7

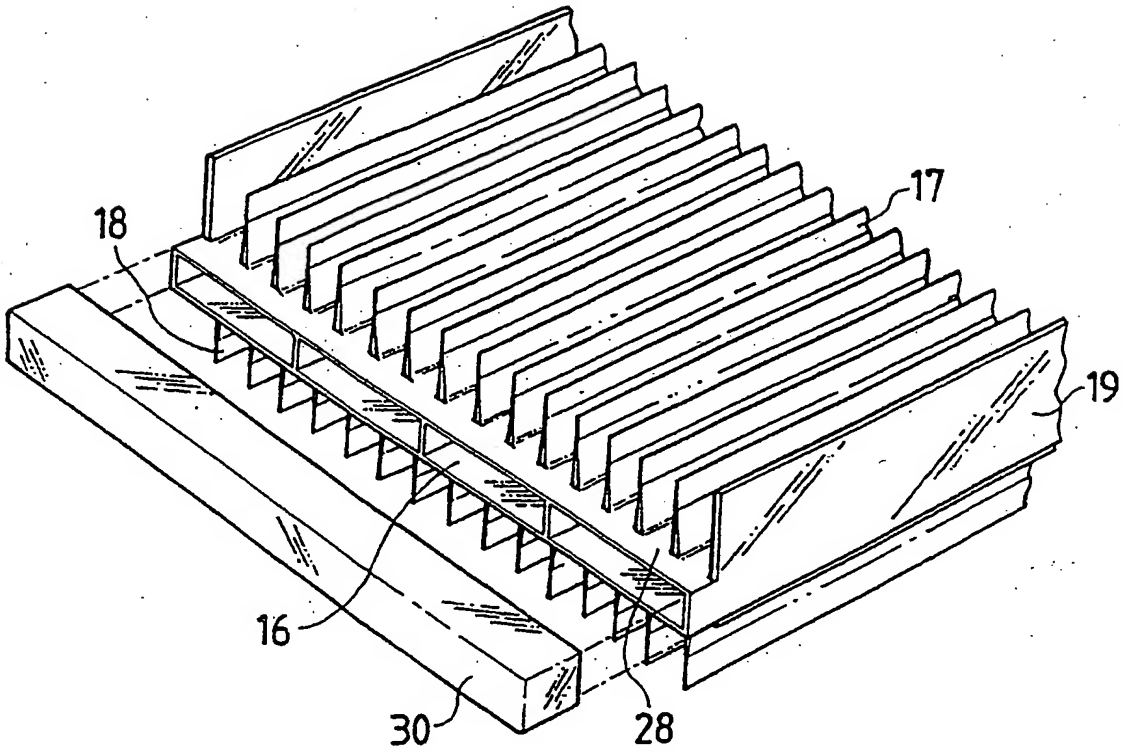

FIG. 8

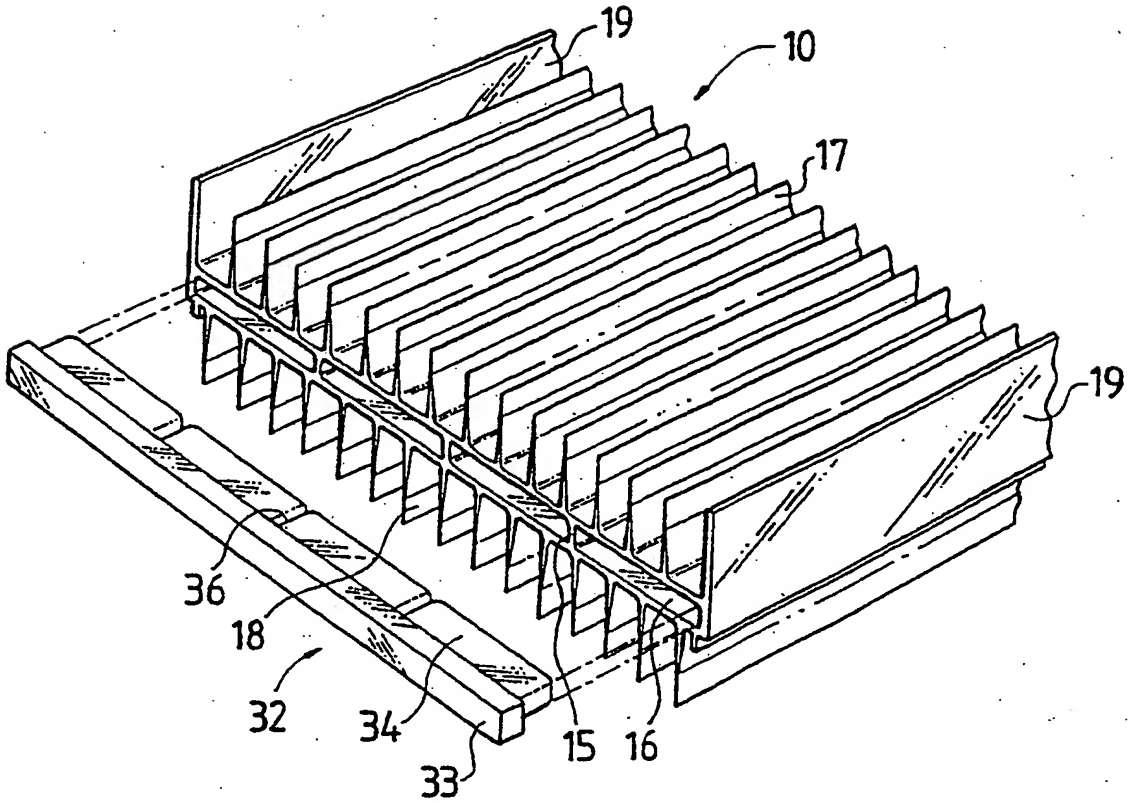

FIG. 9

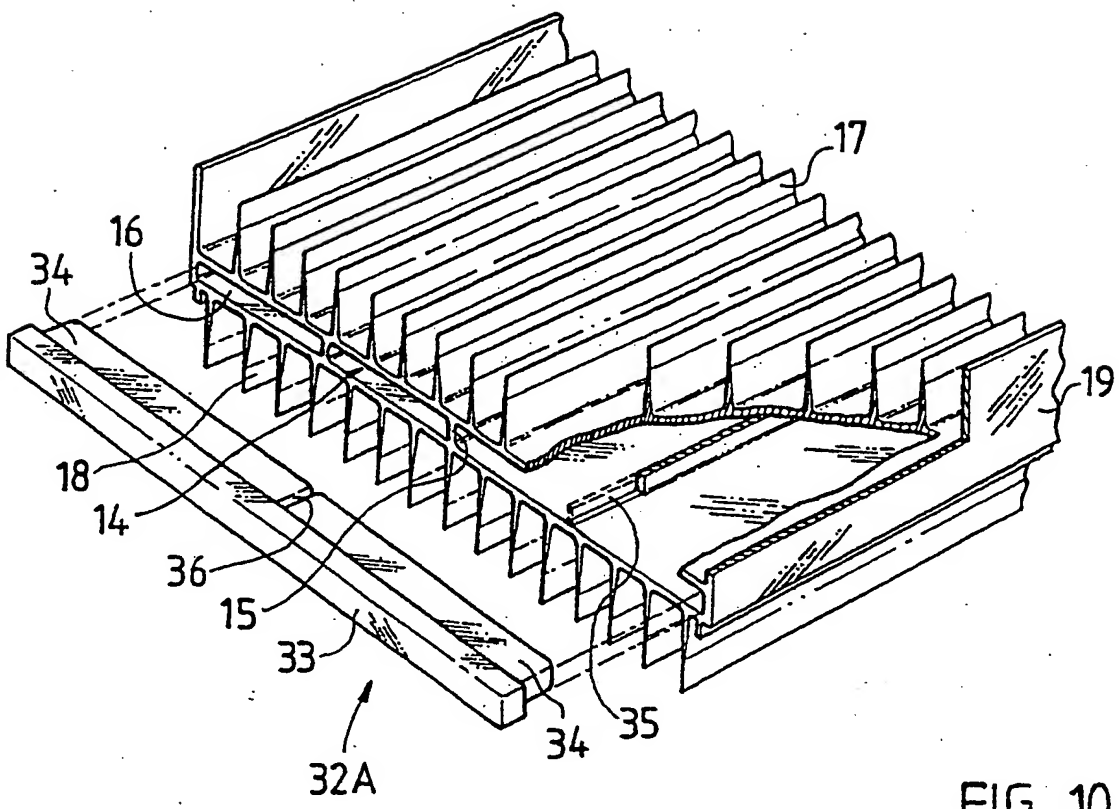

FIG. 10

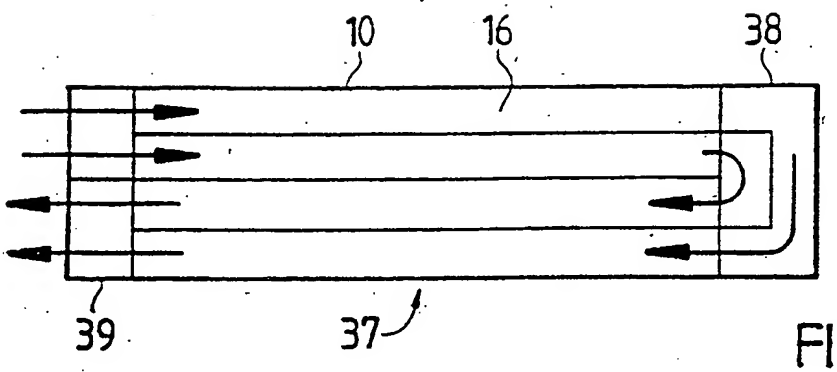

FIG. 11

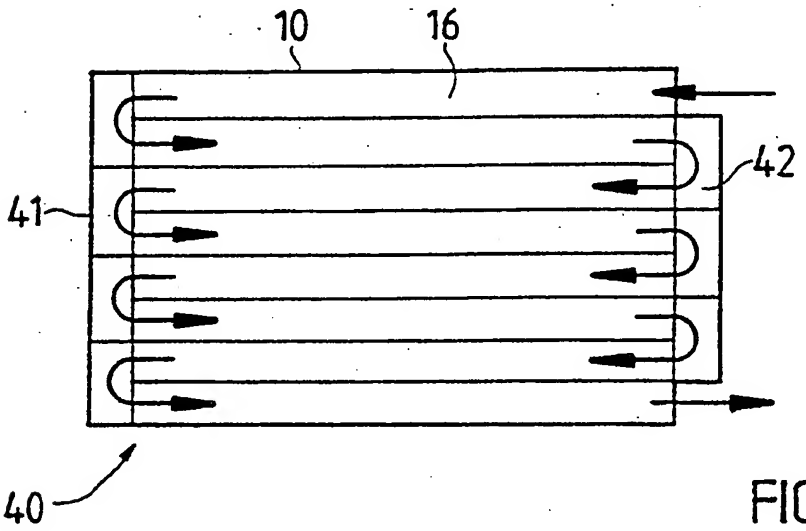

FIG. 12

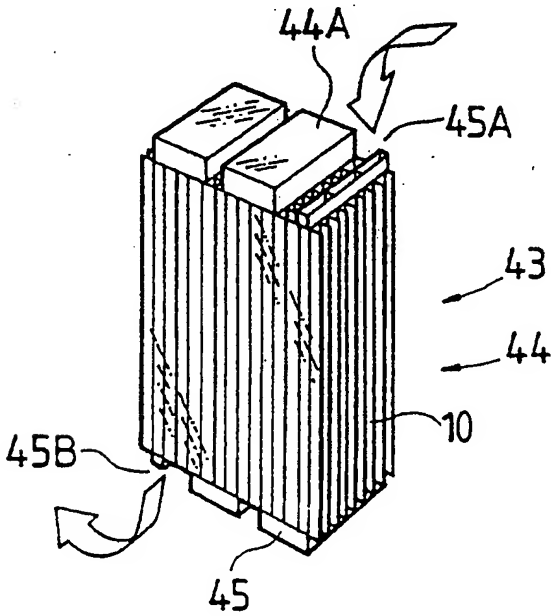

FIG. 13

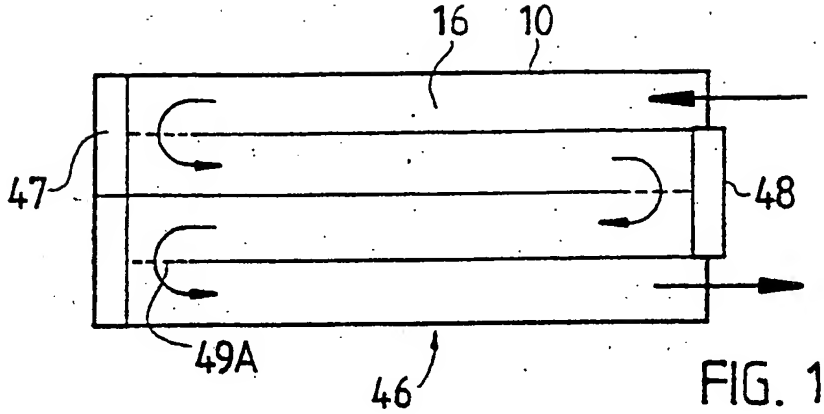

FIG. 14

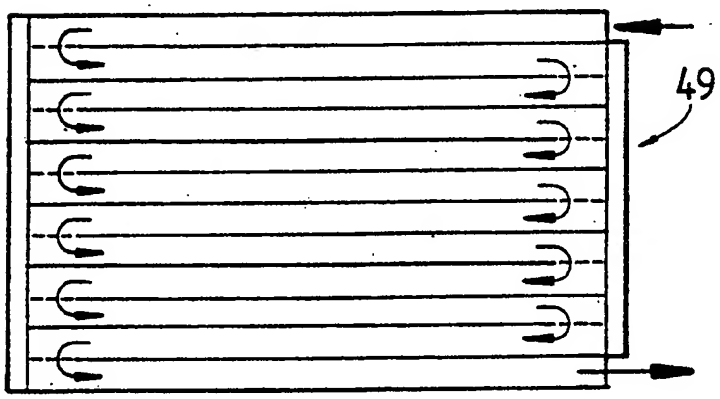

FIG. 15

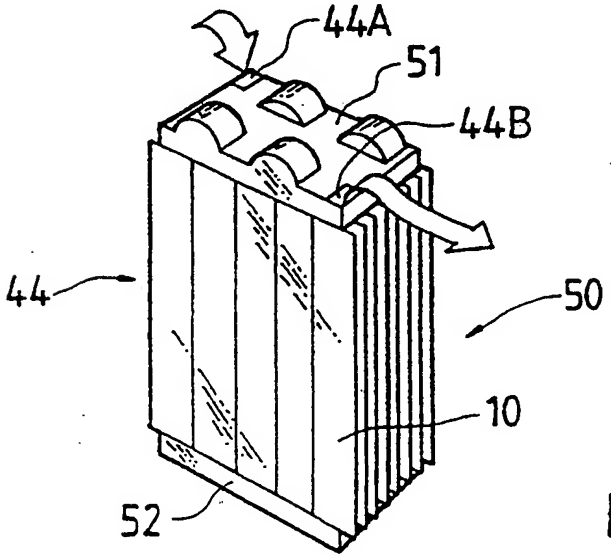

FIG. 16

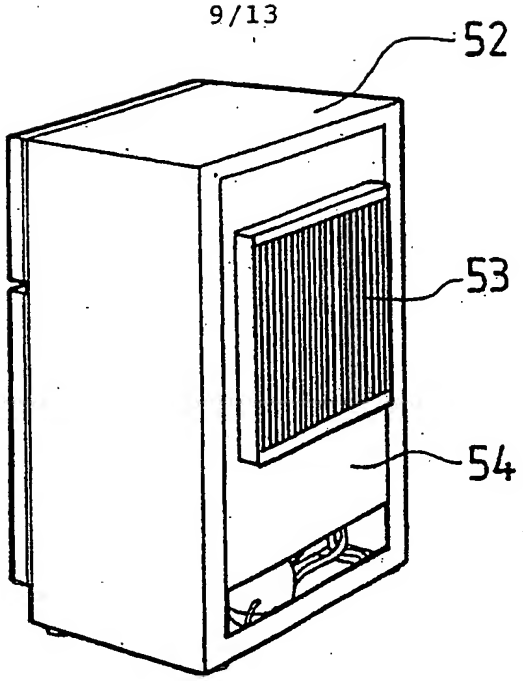

FIG. 17

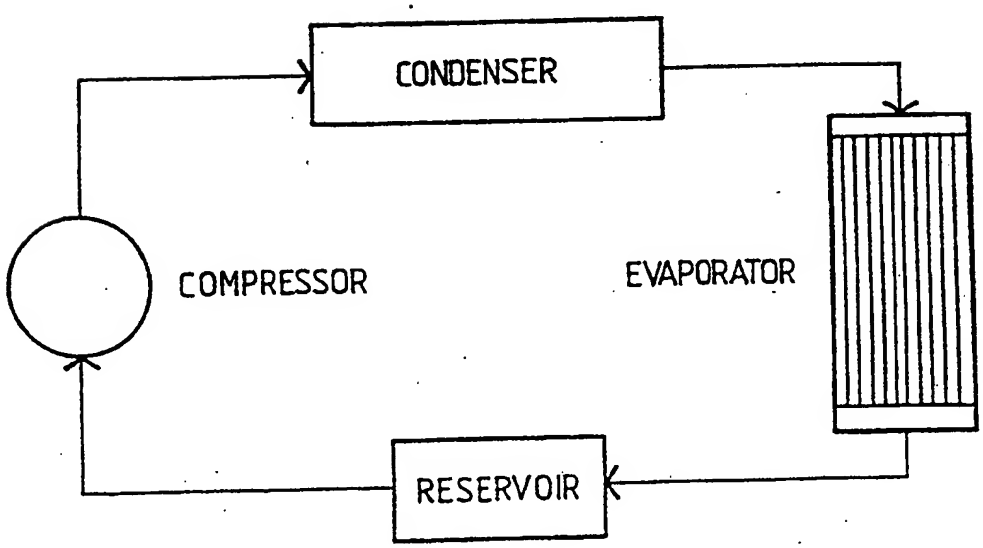

FIG. 18

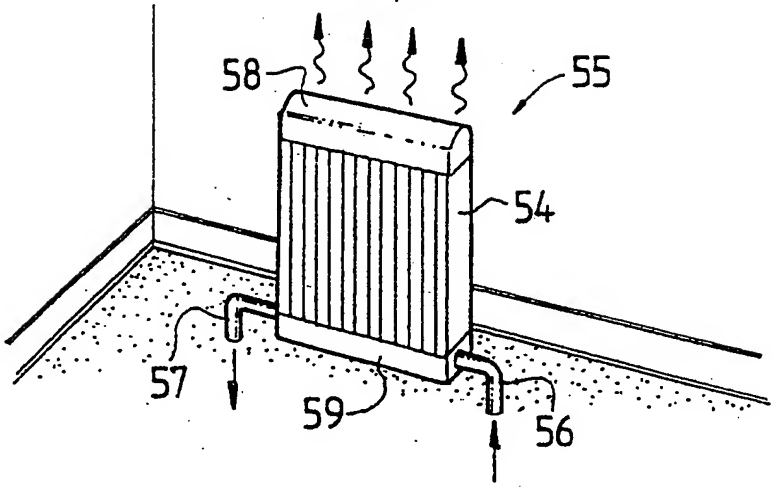

FIG. 19

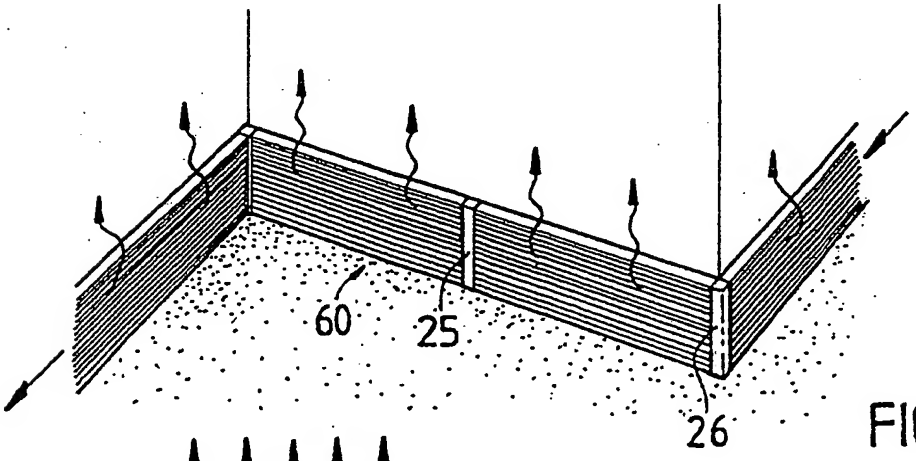

FIG. 20

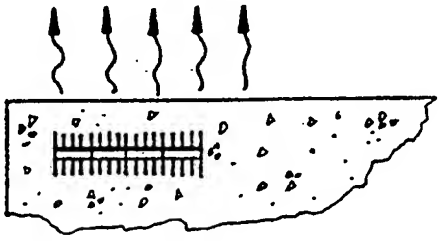

FIG. 21

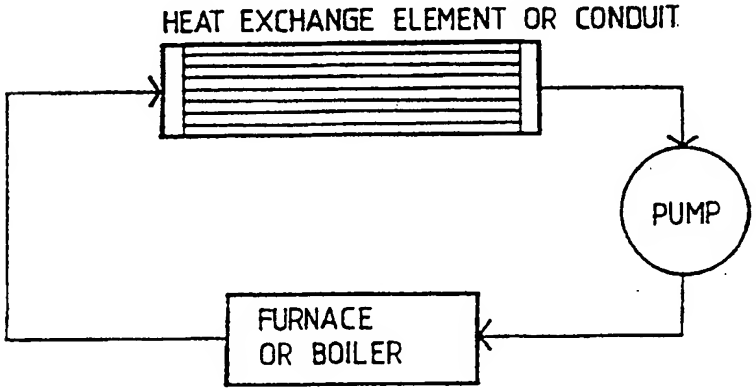

FIG. 22

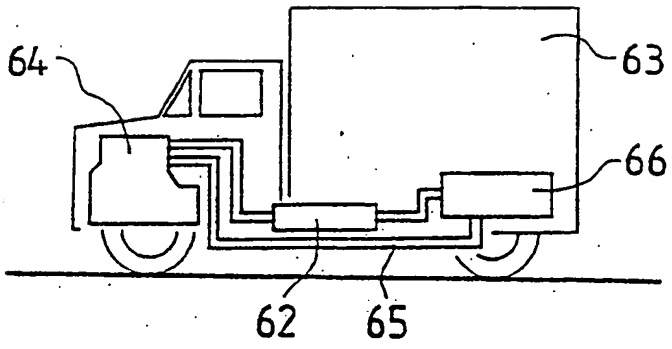

FIG. 23

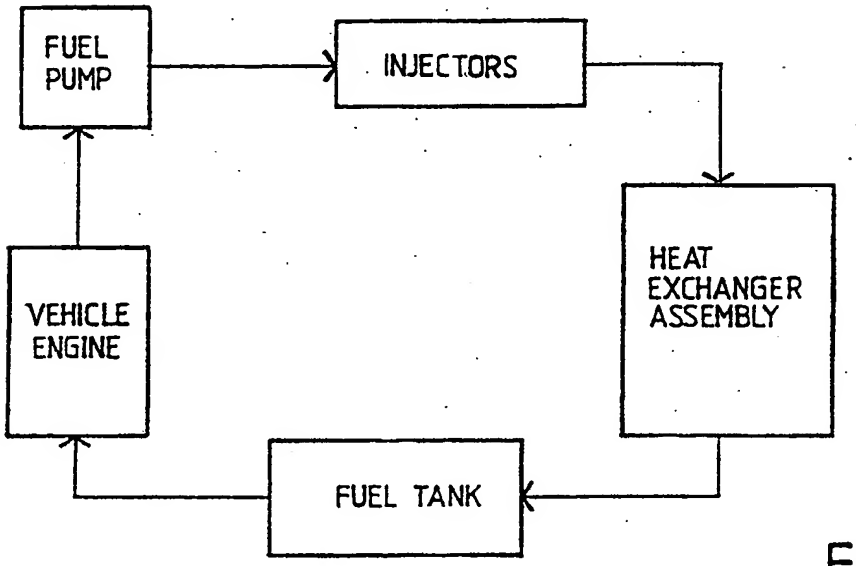

FIG. 24

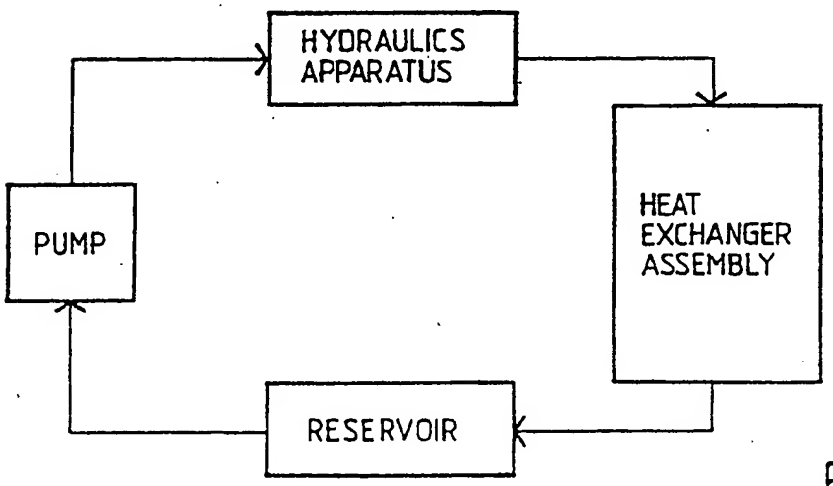

FIG. 25

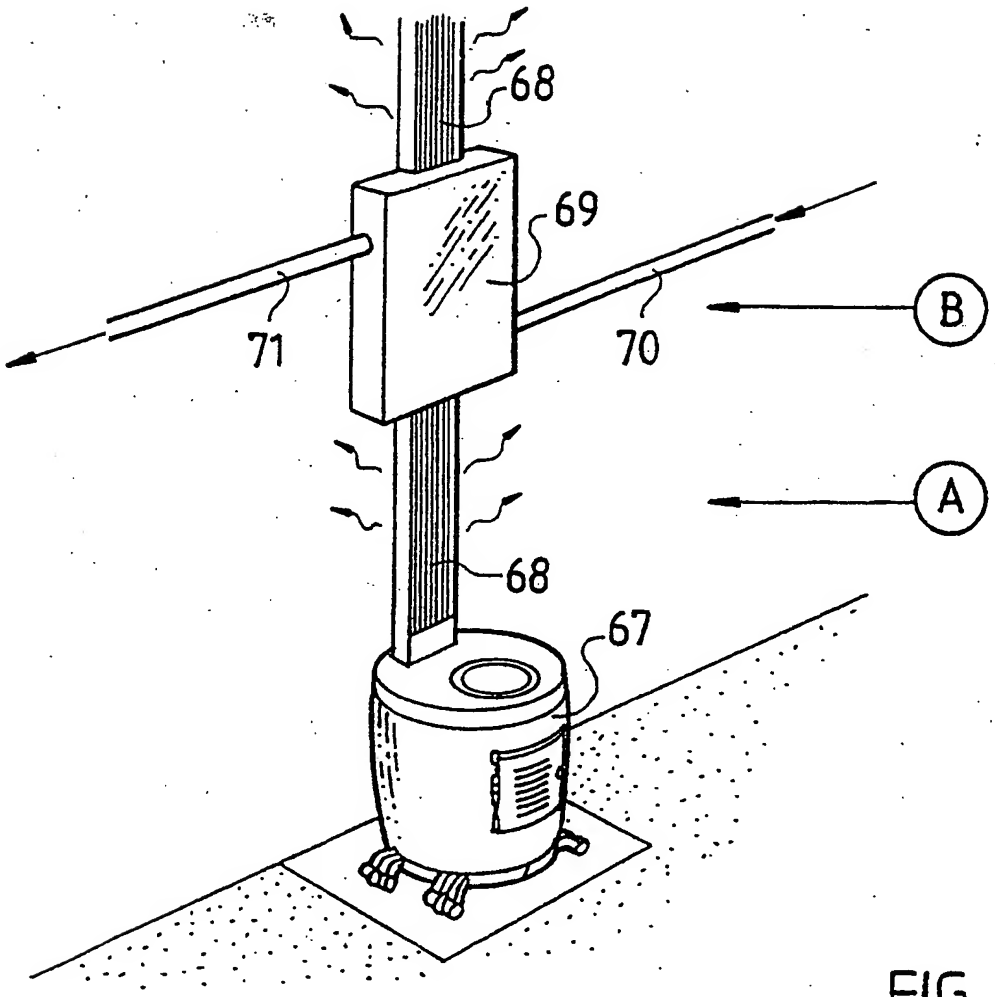

FIG. 26

(A) RADIATE TO AIR

AND

(B) RADIATE TO BATH OF WATER

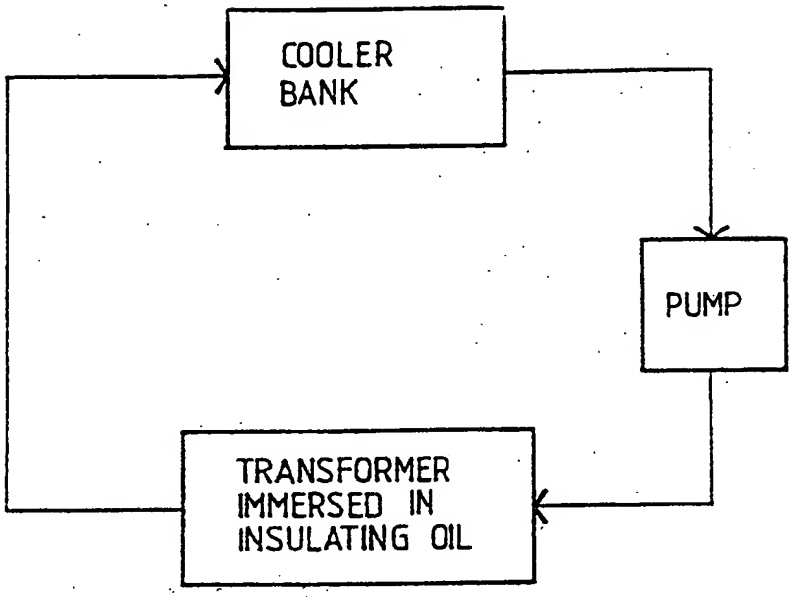

FIG. 27

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 94/00153

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl.[5] F28F 1/16, 1/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC F28F 1/16, 1/22

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC as above

Electronic data base consulted during the international search (name of data base, and where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	EP,A, 461781 (SERVOTOMIC LIMITED) 18 December 1991 (18.12.91) See whole document	1-6, 8-23
X	EP,A, 183211 (NORSK HYRO A/S) 4 June 1986 (04.06.86) See whole document	1-6, 8-23
X	AU,B, 45112/79 (526929)(SULZER BROTHERS LIMITED) 20 September 1979 (20.09.79) See whole document and figures 1-8	1-6, 8-23

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 July 1994 (14.07.94)	22 July 1994 (22.07.94)

Name and mailing address of the ISA/AU	Authorized officer
AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA	B. NGUYEN
Facsimile No. 06 2853929	Telephone No. (06) 2832306

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 94/00153

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
X	DE,A, 1021553 (S.I.R.T.A. SOCIETA ITALIANA RADIATORI TIRAGGIO ATTIVATO, BUSTO ARSIZIO (ITALIEN)) 27 December 1957 (27.12.57) See whole document	1-6, 8-23
X	GB,A, 1050287 (MARSTON EXCELSIOR LIMITED) 7 December 1966 (07.12.66) See whole document	1-6, 10-12, 14-23
X	GB,A, 308976 (MAUTNER) 17 October 1929 (17.10.29) See whole document	1-6, 8-23
A	Patent Abstracts of Japan, M-758, page 149, JP,A, 63-150584 (DAI ICHI HIGH FREQUENCY CO LTD) 23 June 1988 (23.06.88)	
X, P	AU,A, 36226/93 (MELANESIA INTERNATIONAL TRUST COMPANY LIMITED) 13 September 1993 (13.09.93) See whole document	1-23
X	GB,A, 2142129 (BIRD) 9 January 1985 (09.01.85) See whole document	1-6, 8-23

INTERNATIONAL SEARCH REPORT
Information on patent family membe

International application No.
PCT/AU 94/00153

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member
EP 183211	JP 61193733
AU 45112/79	BR 7907427, CH 625611, EP 15915, WO 7900766, ZA 7901190
AU 36226/93	WO 9317290
	END OF ANNEX